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Coleosporium in Europe

Stephan Helfer

Royal Botanic Garden Edinburgh, 20A Inverleith Row, Edinburgh EH3 5LR, UK
Correspondence to *s.helfer@rbge.ac.uk*

Abstract — The species of *Coleosporium* (*Uredinales*) occurring in Europe are not clearly differentiated morphologically. Most taxa in Europe have been combined into formae speciales (ff.spp.) of *Coleosporium tussilaginis* by the majority of researchers. This study includes the taxa *C. doronici*, *C. inulae*, and *C. telekiae* as further ff.spp. in *C. tussilaginis* and redefines the existing ff.spp. *campanulae-rapunculoidis* and *senecionis-silvatici*. It is hoped that this treatment will establish a pragmatic basis on which future taxonomic work can be built.

Key words — rust fungi, cryptic species, host specialism

Introduction

Coleosporium Lév. is a genus of *Uredinales* G. Winter (rust fungi) with the aecial stage parasitic on two-needle pines (*Pinus* spp.) and the telial stage on members of a wide range of angiosperm species. Its distribution is mostly limited to the northern hemisphere, where it is widespread and common in Europe, Asia, and North America (Farr & Rossman 2013, GBIF 2013). However, specimens have also been reported from South America (Arthur 1918, Hennen 2005) and New Zealand (McKenzie 1998). Their presence on two-needle pines has not been confirmed in these southern areas and specimens from Chile were reported to lack the teleomorph, possibly as a result (Arthur 1918). In New Zealand it is likely that already infected hosts from the northern hemisphere were planted or intercepted, and there is one reference of introduced *Coleosporium* rust on an indigenous species but no infections on two-needle pines have been reported (McKenzie 1998, Farr & Rossman 2013).

Léveillé established the genus in 1847. In a short note, he devised a system to bring more clarity into the confusing number of identical names of clearly distinct species and species with multiple names on account of their occurrence on a number of host plant species or genera (Léveillé 1847).

The type species is *Coleosporium campanulae* (lectotype, Laundon 1975).

Table 1. Distribution of *Coleosporium* in host plant families in Europe

Plant Family	Host genera	Host species	Predominant host genus
Asteraceae	35	110	*Senecio* (34 host taxa)
Campanulaceae	10	82	*Campanula* (63 host taxa)
Orobanchaceae	8	38	*Euphrasia* (16 host taxa)
Ranunculaceae	2	9	
Pinaceae	1	10	
Casual hosts & Misdeterminations			Notes
Tropaeolaceae	1	3	non-native plants
Orchidaceae	1	1	border intercept plant
Solanaceae	1	1	South American plants
[*Amaranthaceae*]	[1]	[1]	? misidentified host
[*Amarylidaceae*]	[1]	[1]	? cross-contamination from a common host
[*Boraginaceae*]	[2]	[2]	= *Melampsorella symphyti*
[*Caryophyllaceae*]	[1]	[1]	= *Caeoma coronariae*
[*Rosaceae*]	[1]	[1]	= *Pucciniastrum agrimoniae*

Most authors agree that the European taxa of *Coleosporium* are indistinguishable in their morphology (e.g. Sydow & Sydow 1915, Hylander et al. 1953, Gäumann 1959, Wilson & Henderson 1966, Boerema & Verhoeven 1972). Therefore, many authors used the host plant identity to distinguish species (Gäumann 1959, Minkevičius & Ignatavičiūtė 1991, Brandenburger 1994). Many current inventories treat all *Coleosporium* taxa distinguished in Europe as a single species and synonymise most of the original species into *Coleosporium tussilaginis* (Encyclopedia of Life 2012, Index Fungorum 2012). However, *C. doronici, C. inulae, C. ligulariae*, and *C. telekiae* have never been formally included in *C. tussilaginis*, although Hylander et al. (1953) did synonymise *C. ligulariae* with *C. senecionis*. The three remaining taxa are transferred to *C. tussilaginis* in the present study.

While some authors do not name the taxa included under *C. tussilaginis* (e.g. Majewski & Ruszkiewicz-Michalska 2008, Termorshuizen & Swertz 2011), others distinguish and name them (e.g., Gäumann 1959, Boerema & Verhoeven 1972, Encyclopedia of Life 2012, Bahcecioglu & Kabaktepe 2012), most often as formae speciales, i.e., biologically specialised forms (Eriksson 1894, Anikster 1984, Kirk et al 2008; see also the next paragraph below). The latter approach reflects the host specificity of *Coleosporium* analysed by extensive inoculation experiments (e.g., Klebahn 1904, 1924, Gäumann 1959, EURED names 2012). I follow this approach and extend it to all the European taxa.

Formae speciales (ff.spp.) are defined as taxa below the species level which are morphologically not or hardly distinguishable but are separated by host plant specificity. Nomenclature at this rank is not covered by the provisions of the International Code of Nomenclature for algae, fungi, and plants (McNeill et al. 2012: Article 4 Note 4); therefore in this paper I present them as newly named taxa, rather than as "comb. nov."

This study covers the European taxa of *Coleosporium* on native plants. In the absence of molecular data, a morphological species concept is applied, extended by the use of discrete host plant ranges, in defining the sub-specific taxa of formae speciales, as described above. The aim is to present a pragmatic and effective basis for specimen sampling for molecular analysis, in order to generate data for further studies.

Materials & methods

The herbaria of Berlin (B), Paris (PC), Copenhagen (CP), St Petersburg (LE), Beltsville (BPI) and Edinburgh (E) were consulted in this research. Furthermore information was acquired from Zürich and Bern (Helfer et al. 2011) and from databases at Stockholm (Krypto-S 2012), BPI (Farr & Rossman 2013) and National Herbarium Netherlands (NHL 2012). Label information was extracted and compared with accepted host plant taxonomy using the Plant List (2012) database. Geographical information was checked using Fuzzy Gazetteer (Kohlschütter 2012) and Google Map (©2012 Google) and compiled according to the areas in the Atlas Florae Europaeae delimitations of Europe (Atlas Florae Europaeae 2012). Where reports were from non native or cultivated plants, this is indicated by the use of square brackets [ ]. Type material for *C. telekiae*, *C. doronici*, and *C. ligulariae* was obtained from Berlin (B).

Light microscopy: small portions of herbarium specimens were sectioned by hand and mounted in lactophenol-cotton blue for examination under a Carl Zeiss Axiophot© microscope with Carl Zeiss Axiocam© digital camera equipment. Measurements were achieved using the Axiocam software. Urediniospore dimensions as measured by light microscopy are reported in the following format: (min–) average +/-standard deviation (–max) length × breadth.

Scanning electron microscopy (SEM): small portions of herbarium specimens were removed and fastened to aluminium stubs with adhesive carbon tabs. Prior to sputter coating specimens were examined by a Carl Zeiss Stemi©2000 dissecting microscope, sorus sizes were measured and images taken with Carl Zeiss Axiocam© digital camera equipment as above. Specimens were coated with Palladium for 2min resulting in a deposition of approx 12nm and examined in a Carl Zeiss Supra©55VP SEM at 1-5kV and 5mm working distance. Measurements were achieved using the Axiocam software as above. Morphometric data were subjected to statistical analysis using the statistics package R (R Development Core Team 2011).

Details of the specimens examined are displayed with each taxon. Further information is available from the EURED specimens (2013) list.

Herbarium label images for B, PC, CP, LE and E used in this study can be viewed at the EURED website at E (Helfer et al. 2011). This website is continuously added to and improved.

Results

The herbarium data searches for European taxa of *Coleosporium* resulted in 249 host plant relationships (Table 1), represented in five families. A further seven taxa in five additional host families had been found on intercepted plants or as single occurrences and four taxa in three families were misinterpretations. In the past more than 50 valid names have been used for these rust taxa (EURED names 2012).

The microscopic examinations of the specimens were inconclusive with respect to urediniospore dimensions and sorus characters: while statistically significant differences could be found between most samples involving various host species there were also significant differences between collections of the same host/fungus relationship (EURED stats 2012). Furthermore, data ranges overlapped widely, indicating that urediniospore dimensions and sorus characters are unsuitable for identification purposes and for the characterisation or delimitation of taxa in this genus (EURED spores 2012). Similarly, spore surface characters observed by SEM revealed no distinctive features. It is therefore concluded that, morphologically, the taxa are all part of the same species.

Taxa present in Europe

Coleosporium tussilaginis (Pers.) Lév., in Orbigny, Dict. Univ. Hist. Nat. 12: 786 (1849) **f.sp. *tussilaginis*** Plate 1

≡ *Uredo tussilaginis* Pers., Syn. meth. fung. 1: 218 (1801).

= *Ustilago tussilaginis* Losa, Anales Jard. Bot. Madrid 5: 126 (1945).

Alternate hosts: *Pinus halepensis*, *P. mugo*, *P. nigra*, *P. pallasiana*, *P. pinaster*, *P. sylvestris* (Plate 1), [*P. echinata*, *P. ponderosa*, *P. rigida*].

Primary hosts: *Tussilago farfara*, [*Emilia coccinea*, *Erechtites glomeratus*], *E. hieraciifolius*, [*Euryops acraeus*, *E. evansii*, *Kleinia fulgens*, *K. grandiflora*].

European distribution: pan-European.

Specimens examined:
(as ***C. sp.***) PC0022213.
(as ***C. tussilaginis***) E00458054, E00458055, E00458056, E00458059, E00458060, E00458061.

Urediniospore size: (21.7–)28.3±3.2(–39.6) × (15.9–)20.8± 2.4(–26.6) µm.

Notes: Artificial infections were obtained on *Tropaeolum minus* (*Tropaeolaceae*) and *Schizanthus grahamii* (*Solanaceae*) (Gäumann 1959); weak infections were also obtained on plants of *Senecio vulgaris* (Klebahn 1924), calling into question the biological separation of this taxon from f.sp. *senecionis* discussed below. New specimens in many herbaria are deposited as *C. tussilaginis*, irrespective of host plant identity.

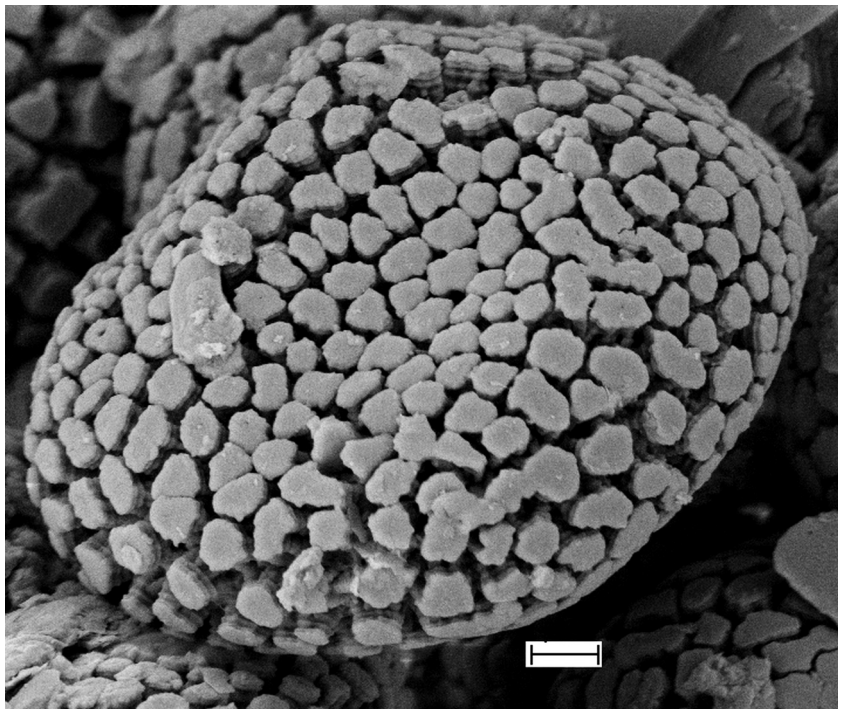

Plate 1 Aeciospore of *Coleosporium tussilaginis* on *Pinus sylvestris*. SEM; bar = 2 μm.

Coleosporium tussilaginis* f.sp. *campanulae-rapunculoidis Boerema & Verh., Netherlands J. Pl. Pathol. 78(Suppl. 1): 7 (1972).

= *Coleosporium campanulae* (Pers.) Fr., Summa Vegetabilium Scandinaviae: 512 (1849), as "*campanulacearum*".

= *Coleosporium campanulae-rapunculoidis* Kleb., Wirtswechselnde Rostpilze: 365 (1904).

= *Coleosporium campanulae-rotundifoliae* Kleb., Wirtswechselnde Rostpilze: 366 (1904).

= *Coleosporium campanulae-trachelii* Kleb., Wirtswechselnde Rostpilze: 366 (1904).

= *Coleosporium tussilaginis* f.sp. *campanulae-rotundifoliae* Boerema & Verh., Neth. Jl Pl. Path. 78(Suppl. 1): 7 (1972).

= *Coleosporium tussilaginis* f.sp. *campanulae-trachelii* Boerema & Verh., Neth. Jl Pl. Path. 78(Suppl. 1): 7 (1972).

Alternate hosts: *Pinus nigra*, *P. sylvestris*.

Primary hosts: *Adenophora liliifolia*, [*A. triphylla*], *Asyneuma giganteum*, *A. limonifolium*, *Campanula alliariifolia*, *C. alpina*, [*C. americana*], *C. barbata*, *C. baumgartenii*, *C. bononiensis*, [*C. californica*], *C. carnica*, *C. carpatica*, *C. caucasica*, *C. cervicaria*, *C. cespitosa*, *C. cochleariifolia*, *C. drabifolia*, *C. erinus*, *C. glomerata*, [*C. grandis*], *C. grossekii*, *C. hagielia*, *C. hawkinsiana*, *C. hispanica*, *C. incurva*, *C. isophylla*, *C. lactiflora*, *C. lanata*, *C. latifolia*, *C. lusitanica*, *C. lyrata*, *C. macrorhiza* subsp. *gypsicola*,

C. medium, *C. moesiaca*, *C. patula*, *C. pelia*, *C. persicifolia*, *C. persicifolia* subsp. *subpyrenaica*, *C. pulla*, [*C. punctata*], *C. pyramidalis*, *C. rapunculoides*, *C. rapunculus*, *C. rhomboidalis*, *C. romanica*, *C. rotundifolia*, *C. rumeliana*, *C. rupestris*, *C. sarmatica*, *C. saxatilis*, *C. scheuchzeri*, *C. serrata*, *C. sibirica*, *C. sparsa*, *C. sparsa* subsp. *sphaerothrix*, *C. spathulata*, *C. speciosa* subsp. *affinis*, *C. speciosa*, *C. stenosiphon*, *C. stevenii*, *C. tatrae*, *C. tomentosa*, *C. trachelium*, *C. transsilvanica*, *C. versicolor*, *C. wanneri*, *Jasione montana*, *Legousia hybrida*, *L. speculum-veneris*, [*Lobelia cardinalis*, *L. xalapensis*], *Michauxia campanuloides*, *M. laevigata*, *Petromarula pinnata*, *Phyteuma betonicifolium*, *P. nigrum*, *P. orbiculare*, *P. scheuchzeri*, *P. spicatum*, [*Triodanis perfoliata*, *Wahlenbergia denticulata*].

European distribution: Au, Be, Bel, Br, Bu, Cg, Cs, Ct, Da, EU, Fe, Ga, Ge, Gr, He, Ho, Hs, Hu, Is, It, La, Lu, Mo, No, Po, Rm, Rus, Se, Sk, Su, Tu, Uk.

Specimens examined:
(as ***C. campanulae***) E00159053, E00458064, PC0022266, PC0022293, PC0022305, PC0022308, PC0022317, PC0022324, PC0022354.

Urediniospore size: (12.0–)20.5±4.8(–30.2) × (9.0–)14.9±3.2(–26.4) µm.

Notes: Boerema & Verhoeven (1972) treat this in three separate formae speciales: f.sp. *campanulae-rapunculoidis*, f.sp. *campanulae-rotundifoliae,* and f.sp. *campanulae-trachelii*. Gäumann (1959) lists several overlapping host ranges and infections on unrelated angiosperms, such as *Tropaeolum minus*, and I see no justification to maintain these three special forms.

Coleosporium tussilaginis* f.sp. *doronici S. Helfer, **f.sp. nov.**

MycoBank MB804294

= *Coleosporium doronici* Namysl., Spraw. Kom. fizyogr. Akad. Umijetn. Krakowie 45: 125 (1911).

Alternate hosts: *Pinus* sp. (presumed).

Primary hosts: *Doronicum austriacum*, *D. columnae*.

European distribution: Au, Cs, Hu, Po, Rm.

Specimens examined:
(as ***C. doronici***) B700015048, B700015049, B700015050, B700015051, B700015052, B700015053, PC0022411, PC0022412.

Urediniospore size: (10.8–)27.8±3.8(–34.1) × (7.0–)19.1±3.6(–24.8) µm.

Notes: This appears to be a geographically as well as biologically separate special form on *Doronicum* sp. (Müller 2003), since its hosts are widely distributed over Europe (Atlas Florae Europaeae 2012). The report in Gäumann (1959) that this rust occurs in Spain is based on a misunderstanding of the geographical name Galicia ("Galizien"), in fact referring to a region in the Tatra mountain border region of Poland.

Coleosporium tussilaginis* f.sp. *inulae S. Helfer, **f.sp. nov.**

MycoBank MB804295

= *Uredo erigerontis* Req. ex Duby, Bot. Gall. Edn 2: 893 (1830), as "*erigeronis*".

= *Coleosporium inulae* Rabenh., Bot. Zeitung 9: 455 (1851).

= *Coleosporium carpesii* Sacc., Rivista Period. Lav. Regia Accad. Sci. Lett. Arti Padova 24: 208 (1874).

= *Coleosporium jasoniae* Gonz. Frag., Trab. Mus. Nac. Cienc. Nat. Madrid, é Bot. 9: 23 (1916).

= *Coleosporium asterisci-aquatici* (Sacc.) Syd. & P. Syd., Ann. mycol. 19: 249 (1921)

Alternate hosts: *Pinus halepensis*, *P. sylvestris*.

Primary hosts: *Asteriscus aquaticus*, *Carpesium cernuum*, *Centaurea hierapolitana*, *Dittrichia graveolens*, *D. viscosa*, *Inula aschersoniana*, *I. aspera*, *I. britannica*, *I. candida*, *I. conyza*, *I. ensifolia*, *I. germanica*, *I. helenioides*, *I. helenium*, *I. helvetica*, *I. heterolepis*, *I. hirta*, *I. methanaea*, *I. oxylepis*, *I. parnassica*, [*I. royleana*], *I. salicina*, *I. spiraeifolia*, *Jasonia tuberosa*.

European distribution: Al, Au, Bl, Bu, Cg, Co, Cs, Ct, Da, Es, Fe, Ga, Ge, Gr, He, Hs, Hu, It, La, Lu, Mk, No, Po, Rm, Rus, Su, Tu, Uk.

Specimens examined:
(as ***C. inulae***) E00458051, E00458052, E00458053, E00458063.
(as ***Uredo erigeronis***) PC0022413, PC0022415.

Urediniospore size: (21.2–)30.3±3.3(–39.5) × (15.7–)23.4±3.1(–30.7) µm.

Notes: A special form on most of the genera of tribus *Inuleae* Cass. of the *Compositae*. Significant damage caused by this rust on elecampane (*Inula helenium*) grown for medicinal use has been reported in Serbia (Pavlovic et al. 2003).

Coleosporium tussilaginis* f.sp. *melampyri Boerema & Verh., Netherlands J. Pl. Pathol. 78(Suppl. 1): 8 (1972).

= *Coleosporium melampyri* (Rebent.) Kleb., Annls Sci. Nat., Bot., sér. 4, 4: 136 (1854).

Alternate hosts: *Pinus mugo, P. sylvestris*.

Primary hosts: *Melampyrum arvense*, *M. nemorosum*, *M. polonicum* Soó, *M. pratense*, [*Schizanthus* sp.].

European distribution: Au, Bel, Br, Cs, Da, Fe, Ga, Ge, He, Ho, Hs, Hu, It, No, Po, Rm, Rus, Sl, Su.

Specimens examined:
(as ***C. euphrasiae***) PC0022164.
(as ***C. melampyri***) E00458065, E00458066, E00458067, E00458068.
(as ***C. tussilaginis***) E00458050.
(as ***C. rhinanthacearum***) PC0022434.

Urediniospore size: (20.6–)25.9±2.6(–32.4) × (13.3–)18.9±2.2(–24.2) µm.

Notes: Heavy infections of *Melampyrum* have been reported in Finland (Pohjakallio & Vaartaja 1948). This rust was found to infect cultivated *Schizanthus* sp. (*Solanaceae*) in Sweden (Hylander et al. 1953) and Norway (Gjaerum 1974); please also see notes to f.sp. *rhinanthacearum* below.

Coleosporium tussilaginis* f.sp. *petasitis Boerema & Verh., Netherlands J. Pl. Pathol. 78(Suppl. 1): 8 (1972).

= *Coleosporium petasitidis* Lév., Annls Sci. Nat., Bot., sér. 3, 8: 373 (1847).

= *Coleosporium petasitis* de Bary, Microscopic fungi: 213 (1865).

Alternate hosts: *Pinus mugo*, *P. nigra*, *P. sylvestris*.

Primary hosts: *Petasites albus*, *P. frigidus*, *P. frigidus* var. *palmatus*, *P. hybridus*, [*P. japonicus*, a naturalized alien in central and northern Europe], *P. kablikianus*, *P. paradoxus*, *P. radiatus*, *P. spurius*.

European distribution: Au, Br, Bu, Cs, Da, Fe, Ga, Ge, Gr, Hb, He, Ho, It, La, No, Po, Rm, Rus, Sk, Su.

Specimens examined:
(as ***C. petasitis***) E00458069, E00458070, E00458071.

Urediniospore sizes: (18.4–)26±2.3(–31.6) × (14.3–)20.7±2.2 (–26.6) µm.

Notes: Together with f.sp. *senecionis*, f.sp. *tussilaginis,* and f.sp. *doronici,* this rust develops on members of the tribus *Senecioneae* Cass. of the *Compositae*.

Coleosporium tussilaginis* f.sp. *pulsatillae Boerema & Verh., Netherlands J. Pl. Pathol. 78(Suppl. 1): 8 (1972).

= *Uredo tremellosa* var. *pulsatillae* F. Strauss, Ann. Wetterauischen Ges. Gesammte Naturk. 2: 89 (1811) ["1810"].

= *Coleosporium pulsatillae* (F. Strauss) Fr., Summa Vegetabilium Scandinaviae: 512 (1849), as "*pulsatillarum*".

Alternate hosts: *Pinus sylvestris.*

Primary hosts: *Anemone alpina*, *A. halleri*, *A. montana*, [*A. patens*], *A. pratensis*, *A. pulsatilla*, *A. slavica*, *Pulsatilla grandis*, *P. nigricans*.

European distribution: Au, Cs, Da, Fe, Ga, Ge, He, Ho, Hu, It, La, No, Po, Rm, Rus, Sk, Su, Uk.

Specimens examined:
(as ***C. pulsatillae***) E00458057, E00458062.

Urediniospore size: (20.8–)28.7±4.2(–40.3) × (15.5–)19.6±2.2(–24.4) µm.

Notes: This special form occurs on members of the *Ranunculaceae*. Despite its morphological likeness, many authors (Braun 1981, 1982, Su et al. 2012) consider this as a separate species. I concur with Boerema & Verhoeven (1972) in the treatment as a special form, as no reliable distinction can be made using morphometric methods.

Coleosporium tussilaginis* f.sp. *rhinanthacearum Boerema & Verh., Netherlands J. Pl. Pathol. 78(Suppl. 1): 8 (1972).

= *Coleosporium rhinanthacearum* (DC) Lév., Annls Sci. Nat., Bot., sér. 3 8: 373 (1847).

= *Coleosporium flavum* Bonord., Abh. Naturf. Ges. Halle: 186 (1860).

= *Coleosporium euphrasiae* (Schumach.) G. Winter, Rabenh. Krypt.-Fl., Edn 2, 1(1): 246 (1881) ["1884"].

Alternate hosts: *Pinus mugo*, *P. sylvestris*.

Primary hosts: *Bartsia alpina*, [*B. lutea*, *B. trixago*], *B. viscosa*, *Euphrasia* × *reuteri*, *E. arctica*, *E. brevipila*, *E. hirtella*, *E. liburnica*, *E. micrantha*, *E. minima*, *E. nemorosa*, *E. parviflora*, *E. pectinata*, *E. picta* subsp. *kerneri*, *E. rostkoviana*, *E. rostkoviana* var. *fennica*, *E. salisburgensis*, [*E. striata*], *E. tricuspidata*, *Odontites litoralis*, *O. purpureus*, *O. vulgaris*, *Orthantha lutea*, *Parentucellia viscosa*, *Pedicularis palustris*, *Rhinanthus*

aestivalis, *R. alectorolophus*, [*R. apterus*], *R. glaber*, *R. glacialis*, *R. pulcher* subsp. *alpinus*, *R. riphaeus*, *R. serotinus*.

European distribution: Au, Be, Bel, Br, Bu, Cg, Cs, Da, Fe, Ga, Ge, Hb, He, Ho, Hs, Hu, It, La, Lu, No, Po, Rm, Rus, Sk, Su, Uk.

Specimens examined:
(as ***C. euphrasiae***) PC0022172, PC0022176, PC0022178, PC0022200, PC0022420.
(as ***C. flavum***) PC0022202.
(as ***C. rhinanthacearum***) E00458082, PC0022434, PC0022459.

Urediniospore size: (19.2–)22.9±2.0(–28.4) × (14.1–)17.9±1.7(–22) µm.

Notes – Besides f.sp. *melampyri* this is the second forma specialis on these more advanced members of the *Orobanchaceae* (Tank et al. 2006). In many herbaria the specimens of rusts on *Rhinanthus*, *Euphrasia*, *Melampyrum* and related hosts are labelled or arranged under any of the names *Coleosporium euphrasiae, C. melampyri, C. rhinanthacearum, C. tussilaginis*.

Coleosporium tussilaginis* f.sp. *senecionis-silvatici Boerema & Verh., Netherlands J. Pl. Pathol. 78(Suppl. 1): 9 (1972)

= *Coleosporium senecionis* f.sp. *senecionis-silvatici* Wagner ex Gäum., in Beitr. KryptogFlora Schweiz 12: 124. 1959.

= *Coleosporium senecionis* (Pers.) Fr., Summa Vegetabilium Scandinaviae: 512 (1849).

= *Coleosporium cacaliae* G.H. Otth, Mitt. naturf. Ges. Bern: 179 (1865).

= *Coleosporium ligulariae* Thüm., Bull. Soc. Imp. Nat. Moscou 52: 140 (1877).

Alternate hosts: *Pinus halepensis*, *P. mugo*, *P. nigra, P. pinaster*, *P. pinea*, *P. sylvestris.*

Primary hosts: *Adenostyles alliariae*, *A. alpina*, [*Delairea odorata*, *Farfugium japonicum* var. *giganteum*, *Hasteola suaveolens*], *Jacobaea alpina*, *J. arnautorum*, *J. erucifolia* subsp. *praealta*, *J. paludosa*, [*Ligularia fischeri*, *L. macrophylla*], *L. sibirica*, *Pallenis maritima*, *Parasenecio hastatus*, *Pericallis cruenta*, [*P. hybrida*, *Senecio candicans*], *S. carpetanus*, [*S. congestus*], *S. doria*, *S. doronicum*, *S. duriaei*, [*S. elegans*], *S. gallicus*, [*S. glaberrimus*], *S. hercynicus*, [*S. inaequidens*], *S. incrassatus*, *S. jacobaea*, *S. leucanthemifolius*, *S. leucanthemifolius* subsp. *vernalis*, [*S. leucostachys*], *S. lividus*, *S. macrophyllus*, [*S. moorei*], *S. nemorensis*, *S. ovatus*, [*S. pulcher*], *S. pyrenaicus*, [*S. scandens*, *S. smithii*], *S. squalidus*, *S. subalpinus*, *S. sylvaticus*, [*S. tristis*], *S. umbrosus*, [*S. viravira*, *S. viscidulus*], *S. viscosus*, *S. vulgaris*, *Tephroseris palustris*.

European distribution: Au, Az, Be, Bl, Br, Bu, Cg, Co, Cs, Da, Fe, Ga, Ge, Gr, Hb, He, Ho, Hs, Hu, It, La, Lu, No, Po, Rm, Rus, Sk, Su, Uk.

Specimens examined:
(as ***C. cacaliae***) PC0022228.
(as ***C. ligulariae***) B700015041, B700015042, B700015044, B700015045, B700015046, B700015047.
(as ***C. senecionis***) E00458072, E00458073, E00458074, E00458075, E00458076, E00458077.

Urediniospore size: (18.6–)25.7±3.2(–37.1) × (11.8–)18.7±2.2(–26.4) µm.

Notes: This is probably a pan-European form. Its distinctness from f.sp. *tussilaginis* needs to be confirmed by detailed host range studies or molecular investigations (see notes there).

Coleosporium tussilaginis* f.sp. *sonchi Boerema & Verh., Netherlands J. Pl. Pathol. 78(Suppl. 1): 9 (1972).

= *Uredo tremellosa* var. *sonchi* F. Strauss, Ann. Wetterauischen Ges. Gesammte Naturk 2: 90 (1811) ["1810"]; see Hylander et al. (1953).

= *Coleosporium sonchi* Lév., Annls Sci. Nat., Bot., sér. 4 2: 190 (1854).

= *Coleosporium sonchi-arvensis* (Pers.) Lév., in Orbigny, Dict. Univ. Hist. Nat. 12: 786 (1849).

Alternate hosts: *Pinus sylvestris*.

Primary hosts: *Aposeris foetida*, *Arnoglossum atriplicifolium*, *Crepis palaestina*, *C. tectorum*, *Dendroseris litoralis*, *Lactuca muralis*, *Lapsana communis*, *Picris cupuligera*, *Sonchus arvensis*, *S. asper*l, *S. brachyotus*, *S. oleraceus*, *S. palustris*, *S. tenerrimus*, *S. uliginosus*.

European distribution: Au, Bel, BH, Br, Bu, Cg, Cs, Da, Fe, Ga, Ge, Hb, He, Ho, Hs, It, La, Lu, No, Po, Rm, Rus, Sk, Su, Uk.

Specimens examined:
(as ***C. sonchi***) E00458078, E00458079.
(as ***C. sonchi-arvensis***) E00458080.

Urediniospore size: (15.9–)21.8±2.5(–29.6) × (9.6–)17.2±3.0(–23.9) µm.

Notes: This forma specialis is restricted to the tribus *Cichorieae* Lam. & DC. of the *Compositae*.

Coleosporium tussilaginis* f.sp. *telekiae S. Helfer, **f.sp. nov.**

MycoBank MB804296

= *Coleosporium telekiae* Thüm., Fungi austriaci exsiccati no. 850 (1873)

Alternate hosts: *Pinus* sp. (presumed)

Primary hosts: *Telekia speciosa*, *Xerolekia speciosissima*.

European distribution: Au, Bu, Cs, [Fe,] Ge, It, [No,] Po, Rm, Sk, Uk.

Specimens examined:
(as ***C. telekiae***) B700004933, B700010610, B700010611, B700015019, B700015020, B700015021, B700015022, B700015023, B700015024, B700015026, B700015027, B700015030, B700015033, B700015034, B700015035, B700015037, B700015038, B700015039, B700015040, E00458058.

Urediniospore size: (15.8–)22.6±3.0(–31.8) × (10.6–)17.2±2.4(–24.1) µm.

Notes: As well as in its natural range in Eastern Central Europe (Kokeš 2004, Dietrich 2009), this rust was recently found on cultivated *Telekia speciosa* in Western Norway (Gjaerum et al. 2008).

Discussion

The present study used the host plant taxonomy of the Plant List (2012) database and revised the host plant spread to at least 239 taxa in 55 genera represented in 4 angiosperm families as well as ten *Pinus* species as alternate hosts (Table 1). The most common host family is the *Compositae,* represented by 96 genera and 706 taxa worldwide and 35 genera and 110 taxa in Europe (Farr & Rossman 2013). Kenneth & Palti (1984), who published a detailed study of

the fungus-plant interactions of this family, found that globally *Coleosporium* was most widely distributed on the tribe *Heliantheae* with 14 genera affected followed by *Senecioneae* with 11 genera. Members of *Heliantheae* are not native in Europe, leaving *Senecioneae* as the most important host tribe, as is confirmed in this study.

To date few molecular investigations into *Coleosporium* have been published. A total of 32 sequences is currently deposited in GenBank (GeneBank 2013), mostly of the Asian/North American species *C. asterum* (Dietel) Syd. & P. Syd. Maier et al. (2003) compared four accessions of *Coleosporium* using the nuclear large subunit ribosomal DNA. In their neighbor joining analysis *C. asterum* (synonym *Stichopsora asterum* Dietel) was clearly separated from *C. cacaliae*, *C. campanulae*, and *C. tussilaginis*, which were not resolved.

Recent molecular studies have revealed the presence of cryptic species among morphologically indistinguishable specimens of *Melampsora* Castagne (Bennett et al. 2011, Milne et al. 2012), a rust genus of comparable host diversity, and it is probable that similar speciation is taking place in *Coleosporium*.

Conclusions

The genus *Coleosporium* is well defined within the *Uredinales*. Its taxa, however, are seriously confused. While host specificity appears to restrict the host range in some taxa, it does not seem to do so in others. Molecular taxonomic investigation of *Coleosporium* taxa is only in its infancy, and new initiatives are urgently needed to deal with the relationships in this genus.

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